



단위영양

Effects of different dietary fiber sources on reproductive performance, blood profiles and milk composition in gestating sows

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This experiment was conducted to evaluate the effects of different dietary fiber sources on reproductive performance, blood profiles and milk composition in gestating sows. A total of 40 multiparous F1 sows (Yorkshire × Landrace) with an average body weight of 216.09 ± 0.59 kg were allotted to 4 dietary treatments with 10 replicates per treatment in a completely randomized design (CRD). The dietary treatments were as follows: 1) CON: basal diet, 2) BP: basal diet + 6% beet pulp, 3) WB: basal diet + 6% wheat bran, and 4) SH: basal diet + 6% soybean hull. In reproductive performance, litter weight gain tended to be higher in BP compared with CON ($p = 0.09$). In blood profiles, glucose concentration at day 105 of gestation was significantly higher in BP, followed by WB, CON, and SH ($p < 0.01$). Similarly, at day 21 of lactation, glucose concentration was significantly higher in BP and WB than in SH ($p < 0.01$). In piglets, total cholesterol concentration at 24 h postpartum was higher in BP than in CON and SH, while WB was higher than SH ($p = 0.02$). Colostrum fat concentration at 24 h postpartum was higher in BP than in the other treatments ($p = 0.04$). Consequently, beet pulp showed greater potential as a dietary fiber source for gestating sows compared with wheat bran and soybean hull.

Key words : gestating sows, lactating sows, beet pulp, wheat bran, soybean hull

Effects of dietary crude protein levels on growth performance, hematological parameters, and intestinal gene expression in weaning pigs

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This study investigated the effects of dietary crude protein (CP) levels on the growth performance, hematological parameters, and intestinal gene expression of weaning pigs. A total of 120 weaning pigs (6.39 ± 0.093 kg) were assigned to 4 treatments with 6 replicates per treatment (5 pigs per pen). The treatments consisted of varying CP levels: 1) CP14: 14% CP, 2) CP16: 16% CP, 3) CP18: 18% CP, and 4) CP20: 20% CP. The results showed that although growth performance increased linearly with higher CP levels ($p < 0.01$), there were no significant differences in overall average daily gain and gain-to-feed ratio among the CP16, CP18, and CP20 groups ($p > 0.05$). Regarding fecal score, the CP16 group exhibited significantly lower scores compared to the CP20 group during Phase I ($p < 0.05$), effectively mitigating post-weaning diarrhea. In Phase II, hematological parameters such as hemoglobin and hematocrit in the CP16 group were not significantly different from those in the CP20 group ($p > 0.05$). Furthermore, the ileal mRNA expression of tight junction proteins (*MUC2*, *OCLN*, and *CLDN1*) in pigs fed 16% CP remained as high as those fed 20% CP ($p > 0.05$). In conclusion, reducing the dietary CP level to 16% serves as an optimal nutritional strategy to maintain growth performance while simultaneously improving gut health and reducing the incidence of diarrhea in weaning pigs.

Key words : crude protein levels, low-protein diet, tight junction proteins, fecal score, weaning pigs

High-dose anandamide supplementation reduces treatment incidence in weaned pigs under elevated ambient temperature

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Post-weaning piglets are exposed to multiple stressors that can be exacerbated by elevated ambient temperatures, leading to impaired health status and increased therapeutic intervention. Anandamide (AEA) has been suggested to modulate stress-related physiological responses; however, its effects on health-related outcomes in weaned pigs under heat stress remain unclear. This study evaluated whether dietary AEA supplementation influences growth performance and treatment incidence (TI) in weaned pigs. A total of 600 weaned pigs were randomly assigned to four treatments: NC (2,000 ppm rice hulls), A1 (1,000 ppm AEA + 1,000 ppm rice hulls), A2 (2,000 ppm AEA), and CA (2,000 ppm citric acid). Supplements were top-dressed onto the basal diet for 7 days after weaning. Growth performance and mortality were evaluated on days 0, 7, and 21, while TI was recorded over 35 days post-weaning. Dietary treatments had no significant impact on growth performance, except for a lower ADG in the A1 group compared with the CA group between days 7 and 21 ($p < 0.05$). However, pigs in the A2 group exhibited lower TI than those in the NC and A1 groups by day 35 ($p < 0.05$), indicating reduced need for therapeutic intervention. In conclusion, AEA supplementation had limited effects on growth performance under high-temperature conditions. However, high dose of AEA was associated with reduced TI, suggesting a potential improvement in health-related outcomes and resilience to post-weaning stress.

Key words : anandamide, growth performance thermal stress, treatment rate, weaning piglets

Influence of dietary electrolyte balance reduction using calcium chloride at expense of limestone on growth performance and odorous compounds of growing pig

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This study was conducted to investigate the effect of dietary electrolyte balance (dEB) on growth performance and concentration of volatile organic compounds and volatile fatty acids in fecal samples of growing pigs. A total of 90 crossbred barrows (34.1 ± 2.97 kg) were assigned to three dietary treatments with six replicates in a randomized complete block design. The dietary treatments consisted of three diets with dEB levels adjusted to 159, 80, or 1 mEq/kg, achieved by replacing limestone with anhydrous calcium chloride in the diets at 0%, 50%, or 100%, respectively. The pigs had free access to water and experimental diets and were reared in controlled environment. The experimental period lasted five weeks. Data were analyzed using the MIXED procedure of SAS, and linear and quadratic effects were evaluated using orthogonal polynomial contrasts. Statistical significance and tendency were defined at $p < 0.05$ and $0.05 \leq p < 0.10$, respectively. Average daily gain tended to decrease linearly as dEB decreased from 0 to 3 weeks ($p = 0.077$) and 0 to 5 weeks ($p = 0.059$). Average daily feed intake decreased linearly ($p = 0.002$) from 3 to 5 weeks and showed a quadratic response ($p = 0.029$) from 0 to 5 weeks as dEB decreased. Gain-to-feed ratio exhibited a quadratic response to decreasing dEB from 0 to 3 weeks ($p = 0.001$) and 0 to 5 weeks ($p < 0.001$). Decreasing dEB tended to reduce fecal p-cresol ($p = 0.086$) and skatole ($p = 0.073$) concentrations but did not affect volatile fatty acids concentrations in fecal samples. In conclusion, lower dEB may mitigate odor emission, but excess reduction of dEB can lead to a decline in growth performance.

Key words : calcium chloride, dietary electrolyte balance, growth performance, growing pigs, odorous compounds

The effect of a low-protein diet on growth performance and fecal odor compounds in finishing pigs

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This study examined the effects of reducing dietary crude protein (CP) on growth performance and fecal odor-related compounds in finishing pigs. A total of 90 crossbred ([Yorkshire × Landrace] × Duroc) finishing pigs with an average body weight (BW) of 76.6 ± 2.43 kg were used. Pigs were allocated to three dietary treatments (10%, 12%, and 14% CP) in a randomized complete block design based on BW, with six replicates per treatment and five pigs per pen. All diets met or exceeded the recommended nutrient requirements except CP. On days 0, 21, and 35, BW and feed leftover were recorded, and fecal samples were collected on days 22 and 34 from the median-weight pig in each pen to determine volatile organic compounds and volatile fatty acids. Data were analyzed using the MIXED procedure of SAS, and linear and quadratic effects of dietary CP were evaluated by orthogonal polynomial contrasts. Lowering dietary CP resulted in linear decreases in BW and average daily gain during days 0–21 ($p < 0.05$), and gain-to-feed ratio tended to decrease ($p = 0.0751$). However, no differences in growth performance were observed during days 21–35 or over the entire period. Phenol and indole were not detected in fecal samples. On day 34, fecal p-cresol increased linearly with decreasing CP ($p < 0.05$), whereas skatole showed a tendency to increase ($p = 0.0610$). In fecal samples, isovaleric acid tended to increase ($p = 0.0883$), and n-valeric acid increased linearly ($p < 0.05$) as dietary CP decreased. Overall, reducing CP from 14% to 10% while meeting essential amino acid requirements did not affect growth performance over the entire experimental period, although some fecal odor-related compounds increased.

Key words : finishing pig, fecal odor compounds, growth performance, low protein

Effects of palm kernel by-product type and inclusion level on growth performance, pork quality, and carcass characteristics in growing-finishing pigs

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This experiment was conducted to evaluate the effects of palm kernel by-product type and inclusion level on growth performance, pork quality, and carcass characteristics in growing-finishing pigs. A total of 126 growing pigs ([Yorkshire × Landrace] × Duroc), average 35.09 ± 0.47 kg body weight (BW), were allotted to 6 treatments by BW and sex in 3 replications with 7 pigs per pen in a randomized complete block (RCB) design. Dietary treatments included palm kernel expeller (PKE) or palm kernel meal (PKM) supplemented with 0.04% β -mannanase at inclusion levels of 4, 8, 12%. In growth performance, average daily gain (ADG) was higher in pigs fed PKM diets than in those fed PKE diets during the late growing-finishing phase and whole experimental period ($p = 0.05$; $p = 0.04$). Gain to feed ratio (G:F) was increased as the inclusion level of palm kernel by-products increased during weeks 0 to 9 ($p = 0.02$). No significant differences were observed in pork quality traits ($p > 0.05$). However, backfat thickness increased with increasing inclusion levels of palm kernel by-products ($p = 0.02$), and carcass grade was significantly improved in pigs fed PKM diets compared with those fed PKE diets ($p = 0.03$). Consequently, PKM showed greater potential as a feed ingredient than PKE when supplemented with β -mannanase in growing-finishing pig diets.

Key words : growing-finishing pigs, palm kernel expeller, palm kernel meal, β -mannanase

Dietary bacteriophage on growth performance, fecal microbiome, diarrhea incidence, and nutrient digestibility in weaning pigs

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This experiment was conducted to evaluate the effects of dietary bacteriophage supplementation on growth performance, nutrient digestibility, diarrhea incidence and fecal microbiome in weaning pigs. A total of 160 weaning pigs ([Yorkshire × Landrace] × Duroc), with an average initial body weight of 8.30 ± 0.14 kg, were allotted to 4 treatments in a randomized complete block (RCB) design. Dietary treatments included supplementation with 0, 0.05, 0.10, or 0.15% bacteriophage targeting *E. coli*, *Salmonella* spp., and *C. perfringens* for 5 weeks. The results showed that average daily gain (ADG) increased linearly during the late weaning and overall periods, leading to a tendency for increased body weight at week 5 ($p = 0.03$; 0.04; 0.10). Gain to feed ratio (G:F) tended to increase linearly during the early weaning period ($p = 0.07$). In addition, diarrhea incidence decreased linearly during the late weaning and overall periods with increasing levels of bacteriophage supplementation ($p = 0.07$; 0.04). Weighted UniFrac and LEfSe analyses indicated selective modulation of fecal microbial communities, including reduced abundance of Proteobacteria and increased abundance of beneficial genera such as *Bifidobacterium* and *Prevotella*. Consequently, supplementation with 0.15% bacteriophage improved growth performance and reduced post-weaning diarrhea through selective modulation of gut microbiota without disrupting microbial diversity.

Key words : bacteriophage, weaning pigs, growth performance, fecal microbiome

Weaning weight-related differences in growth performance, nutrient digestibility, blood profiles, and intestinal morphology in pigs

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This study was conducted to evaluate whether weaning weight (WW) at 28 d of age could serve as an indicator of postweaning robustness by comparing growth performance, nutrient digestibility, blood profiles, and intestinal morphology of pigs differing in body weight (BW). Among a total of 124 pigs, 74 pigs corresponding to the upper and lower 30% of the WW distribution were selected and assigned to heavy BW (HBW) and light BW (LBW) groups, respectively, and monitored until d 56 of age. In this study, the HBW group showed higher ($p < 0.05$) body weight, average daily gain, and apparent total tract digestibility of dry matter, crude protein, and gross energy than the LBW group. Differences in intestinal morphology were observed, HBW group exhibiting higher ($p < 0.05$) villus height (VH), villus width (VW) and villus height to crypt depth ratio (VH:CD). Blood profiles indicated elevated ($p < 0.05$) cortisol, tumor necrosis factor- α , interleukin-6, and interleukin-10 levels in LBW group, reflecting enhanced systemic stress and inflammatory activation. Correlation analysis further demonstrated positive associations between WW and growth performance and nutrient digestibility, VH, VW and VH:CD while showing negative correlations with inflammatory and stress markers. These results indicate that WW is closely linked to postweaning physiological responses and serve as a practical predictor of robustness, digestive capacity, and growth potential during the nursery phase.

Key words : weaning weight, robustness, nutrient digestibility, cytokines, intestinal morphology

Solvens[®] supplementation improved immune and gut health in weaned piglets vaccinated with PRRSV

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Porcine reproductive and respiratory syndrome virus (PRRSV), which belongs to the family *Arteriviridae*, causes substantial economic losses in the pig industry worldwide. Solvens[®] is a feed additive based on *Bacillus* (*B. licheniformis* and *B. subtilis*). The objective of this study is to evaluate the efficacy of Solvens[®] on growth performance, gut health and the immune system in weaned piglets vaccinated with Porcine reproductive and respiratory syndrome virus (PRRSV). 96 crossbred weaning pigs are randomly allotted two treatments (12 replicates per treatment) based on body weight and the experiment conducted 28 days. The dietary treatments included VAC (basal diet + vaccinated with PRRSV) and VAC+PRO (VAC + 0.04% of solvens). VAC+PRO showed higher ADG and FCR during d 8–28, d 1–28, and BW at d 28 than VAC. Solvens[®] supplementation improved Diarrhea score during d 1–7 and d 1–28. Also, Solvens[®] supplementation improved ATTD of DM, CP, EE, and OM on d 7; DM and CP on d 14; and DM, CP, and GE on d 28. Solvens[®] supplementation improved AID of CP, GE, and OM on d 28. On d 7 and d 28, Solvens[®] supplementation improved IgG and serotonin TNF- α , IL-6, and cortisol. VAC+PRO showed higher villus height and lower crypt depth compared to VAC. Fecal acetate and propionate concentrations were significantly increased on d 28 in VAC+PRO. VAC+PRO showed lower *Ruminococcus* abundance on d 28 compared to VAC. These results consistently demonstrate that Solvens[®] supplementation improves overall health of piglets under PRRSV vaccination-induced immune stress.

Key words : weaned piglets, PRRSV, probiotics, immune, gut health

Partial replacement of molasses with monosodium glutamate–condensed molasses soluble improves growth performance while maintaining gut health in finishing pigs

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A total of 210 crossbred pigs [(Landrace × Yorkshire) × Duroc] with an initial body weight (BW) of 53.92 ± 2.24 kg were used in this experiment. The pigs were randomly assigned to 1 of 3 dietary treatments in a completely randomized design, with 14 replicates of 3 females and 2 males / pen. The dietary treatments were CON: basal diet containing 4% Molasses; TRT1, basal diet with 2% molasses and 2 % Monosodium Glutamate–Condensed Molasses Soluble (MSG-CMS), while TRT3, basal diet with 4% MSG-CMS. The test diets were fed: Phase 1 (week 0–5) and Phase 2 (week 5–10). Data was analyzed using IBM SPSS version 16.0 via one-way ANOVA, difference among the treatments were identified using Tukey's test. $p < 0.05$ was set as significant. Across phase 1, 2, and the overall experimental period, the inclusion of 0.4% MSG-CMS in pigs diet exhibited higher ($p < 0.05$) average daily gain and average daily feed intake compared with the other treatment groups. However, no significant differences were observed in nutrient digestibility of dry matter, nitrogen, or energy, backfat thickness and lean meat percentage, nor meat quality and carcass characteristic among treatments. At week 10, pigs receiving 0.4% MSG-CMS exhibited a significantly higher ($p < 0.05$) blood insulin concentration compared to the other groups. The alpha diversity indices (observed features, Chao1, Shannon, Simpson, and Pielou's evenness) were not influenced by dietary treatments. Similarly, beta diversity analysis based on Bray–Curtis and unweighted UniFrac distances revealed no clear separation among treatment groups. At the phylum level, CON group showed the most abundant *Proteobacteria*, followed by *Bacteroidota*. At the genus level, *Prevotella* was more abundant in the CON group, followed by *Bacteroides*. In contrast, LEfSe consistently showed significant overgrowth of *Clostridium sensu stricto 1* *Clostridium_sensu_stricto* in TRT2 group. In summary partial or complete replacement of molasses with MSG-CMS (up to 0.4%) improved growth performance (ADG and ADFI) in finishing pigs without negatively affecting feed efficiency, nutrient digestibility, carcass traits, meat quality, or gut microbial diversity. Overall, MSG-CMS can be considered a viable alternative to molasses in finishing pig diets, offering modest performance benefits without adverse physiological or microbiological effects.

Key words : nutrient digestibility, meat quality, condensed molasses, blood profile

Dietary Mycofix[®] plus 5.0, a toxin binder mitigates multi-mycotoxin induced impairments in growth performance, gut integrity, and reproductive indicators in finishing gilts

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Multi-mycotoxin (MMT) contamination in swine diets poses a major threat to animal health and productivity, particularly female gilts are susceptible, often exhibiting impaired growth, nutrient utilization, and intestinal integrity. To address this challenge, $n = 63$ gilts [Landrace $\times$ Yorkshire) $\times$ Duroc; 70.84 ± 2.68 kg; 18 weeks old] were randomly allocated to three treatments in a completely randomized design for 7 weeks (7 replicates/treatment; 3 gilts/pen) to evaluate whether Mycofix[®] Plus 5.Z, a toxin deactivator can mitigate the adverse effects of multi-mycotoxin [Zearalenone (ZEN), Deoxynivalenol (DON), Fumonisin (FUM)] on performance of finishing gilts. The diets were CON: basal diet; TRT1 (Challenge): a basal diet artificially contaminated with a MMT premix (770 g/ton) providing 250 ppb ZEN, 1,500 ppb DON, and 5,000 ppb FUM B1; and TRT2: TRT1 diet mixed with 2 kg/ton Mycofix[®] Plus 5.Z. All data were analyzed using the General Linear Model procedure of SAS (SAS 9.4, Institute Inc., Cary, NC, USA) using a one-way ANOVA. Differences among treatment means were determined using Tukey's multiple range test, and significance was declared at $p < 0.05$. Our results demonstrate that dietary Mycofix[®] Plus 5. Z significantly improved ($p < 0.05$) final body weight, average daily gain, and feed intake in gilts compared with the MMT group. Furthermore, mycotoxin challenge reduced ($p < 0.05$) dry matter and nitrogen digestibility; however, Mycofix[®] supplementation significantly restored nitrogen utilization. Intestinal morphology of MMT group showed significantly decreased ($p < 0.05$) villus height and VH:CD ratio and increased crypt depth. Similarly, the regulation of tight junction proteins (Claudin-4, Zonula Occludens-1, and Occludin) was significantly improved ($p < 0.05$) with Mycofix[®] Plus 5.Z. While alanine aminotransferase, gamma-glutamyl transferase, and malondialdehyde levels had tended to reduce in TRT2. At the phylum level, TRT1 exhibited dysbiosis (increased Bacillota. reduced Bacteroidota). Furthermore, at genus level, Mycofix[®] supplementation increased beneficial *Lactobacillus* and SCFA-producing bacteria while reducing harmful taxa. Based on this result, we suggest that adding 2 kg/ton a mycotoxin deactivator in gilts diet would be beneficial to counteract toxicity and maintain performance under contaminated feeding conditions.

Key words : zearalenone, deoxynivalenol, fumonisin, physiological responses, gut integrity

Effects of supplementing zinc oxide and *Tenebrio molitor* larvae to nursery pig diets

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Weaning impairs intestinal homeostasis and growth in nursery pigs, and pharmacological ZnO has been widely used to alleviate these challenges. However, environmental concerns regarding ZnO have increased interest in sustainable alternatives such as *Tenebrio molitor* larvae (TML). Therefore, this study evaluated the effects of ZnO and TML on growth performance and intestinal health in nursery pigs under unhygienic conditions. A total of 128 pigs were assigned to four dietary treatments: basal diet (CON), basal diet + 2,000 ppm ZnO, basal diet with 5% TML, and basal diet containing both ZnO and TML. Partial replacement with TML improved body weight and average daily gain, while both ZnO and TML reduced feed intake and improved feed efficiency. Diarrhea scores were reduced by both additives, and TML decreased inflammatory markers and improved intestinal barrier integrity without negatively affecting intestinal morphology. These results suggest that TML may serve as a sustainable nutritional strategy to partially replace pharmacological ZnO in nursery pig diets.

Key words : nursery pigs, pharmacological zinc oxide, *Tenebrio molitor* larvae, under unhygienic condition, weaning stress

A functional bioactive complex based on sustainable nutrition improves production performance, reduces harmful gas emissions, and mitigates lipopolysaccharide-induced immune stress in laying hens

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This study aimed to evaluate the effects of a sustainability-oriented functional bioactive compound (FBC, Probiotic and beta glucan) on production performance, egg quality, nutrient digestibility, excreta gas emissions, and immune responses under lipopolysaccharide (LPS)-induced stress in laying hens. For a period of 12-weeks $n = 240$ Hy-Line Brown laying hens (38 weeks of age) were randomly assigned to two dietary treatments: a basal diet (CON) or the basal diet supplemented with FBC (TRT, 0.1 % each), with 10 replicates per treatment and 12 hens per replicate. At the end of the feeding trial, an independent experiment was conducted to assess immune responses. $N = 30$ layers from each treatment were selected randomly and 15 birds were intraperitoneally injected with LPS (100 $\mu\text{g/kg}$) and the remaining 15 injected with an equivalent volume of saline. This experiment followed a 2×2 factorial design, with FBC supplementation and LPS challenge as the main factors. All experimental data were analyzed using SAS software (Version 9.4, using one-way ANOVA). Differences among treatment means were determined using Tukey's multiple range test, and significance was declared at $p < 0.05$. Birds fed FBC supplement showed increased body weight from week 6 and 12, and egg from weeks 7 to 12. Also, average egg weight increased during the late phase of the experiment (weeks 9–12). In terms of egg quality, FBC increased albumen height at week 6 and improved Haugh unit, eggshell strength, and eggshell thickness at week 12. However, FBC increased egg moisture loss on day 7 of storage at week 12. Nutrient digestibility analysis indicated that FBC enhanced the digestibility of nitrogen and Gross energy. Furthermore, FBC reduced ammonia and hydrogen sulfide emissions from excreta. Under LPS challenge, FBC reduced serum concentrations of pro-inflammatory cytokines, including interleukin-6 and tumor necrosis factor- α , with significant interactions observed between diet and LPS treatment suggesting that FBC partially alleviated LPS-induced inflammatory responses. In conclusion, dietary supplementation with FBC improved production performance and nutrient utilization reduced harmful gas emissions, and exerted anti-inflammatory and immunomodulatory effects under LPS-induced stress. We infer that FBC could serve as a functional feed additive for sustainable layer production.

Key words : immune modulation, lipopolysaccharide challenge, laying hens

Effects of dietary starch and CP levels on growth performance, breast meat quality, gut health, and stress indicators in broiler chickens raised under heat stress

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This study was conducted to investigate the effects of dietary starch and crude protein (CP) levels on growth performance, breast meat quality, gut health, and stress indicators in broiler chickens raised under heat stress. A total of 192 21-day-old Ross 308 broiler chickens were randomly allotted to 4 treatments with 8 replicates in a 2×2 factorial arrangement with two starch levels (43.0% and 37.9%) and two CP levels (19.5% and 18.0%). All birds were exposed to cyclic heat stress ($31.3 \pm 0.7^\circ\text{C}$ for 10 h/d and $23.5 \pm 0.6^\circ\text{C}$ for 14 h/d). Results indicated that dietary starch and CP levels had no significant interaction on growth performance, feather corticosterone, and ileal morphology. However, significant interactions ($p < 0.05$) between starch and CP levels were observed in ileal nutrient digestibility. A tendency toward an interaction ($p = 0.071$) was observed for breast meat yield. For main effects of starch levels, birds fed the high-starch diet had significantly greater ($p < 0.05$) water-holding capacity and TEER compared to those fed the low-starch diet. Regarding the main effects of CP levels, birds fed the lower CP diets showed increased ($p < 0.05$) CP digestibility and TBARS but decreased ($p < 0.05$) total antioxidant capacity, catalase activity, and TEER. In conclusion, dietary starch and CP levels do not affect growth performance under heat stress but interact to influence nutrient digestibility. Higher dietary starch improves breast meat quality and gut barrier function, whereas reduced dietary CP enhances protein digestibility while reducing antioxidant status and intestinal barrier function in broiler chickens exposed to heat stress.

Key words : broiler chicken, growth performance, gut health, heat stress, protein, starch

Temporal dynamics and sex-specific differences in the gut microbiota of AA+ broilers

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The gut microbiota interacts with the host intestinal environment and plays a crucial role in the metabolism, immunity, and intestinal function of broiler chickens. In addition, sex is recognized as one of the major factors influencing the composition of gut microbial communities. This study was conducted to investigate the changes in gut microbiota across different growth stages and the sex-related differences in Arbor Acres Plus broilers. A total of 100 broiler chickens were raised for 20 days at the experimental farm of Yanbian University. Fecal samples and ileum contents (IC) were collected on 2, 10, 20 days. The collected samples were analyzed by amplifying the V3–V4 region of the 16S rRNA gene and sequencing using the Illumina MiSeq platform. The results showed that microbial diversity increased with the growth of broilers, and higher diversity was observed in ileum contents compared to fecal samples. At the genus level, the relative abundance of *Lactobacillus* was highest at day 20 (D20) in both fecal and ileum samples. In fecal samples, the abundance of *Lactobacillus* at D20 was significantly higher than at D2 and D10 ($p < 0.05$). *Faecalibacterium* also showed the highest abundance at D20, and its abundance in ileal content (IC) samples at D20 was significantly higher in females than in males ($p < 0.05$). These findings suggest that both growth stage and sex significantly shape the gut microbial composition in broilers, providing valuable insights for developing sex-specific and age-targeted strategies to optimize gut health and production performance. Supported by NRF/MSIT (RS-2024-00344849).

Key words : gut microbiota, broiler, 16S rRNA gene

Real-time individual broiler monitoring system using YOLOv12 with WIoU v3 and ByteTrack for automated feeding and drinking behavior analysis

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Monitoring individual broiler behaviors is essential for early disease detection and flock management, yet manual observation remains impractical for continuous monitoring. This study aimed to develop a real-time system that detects and tracks individual broilers to automatically quantify feeding and drinking frequency. Video data were collected from a commercial broiler farm using overhead-mounted fixed cameras capturing 19 birds per frame, and YOLOv12m with ByteTrack was employed for detection and tracking, with ROIs defined around feeders and drinkers. Among the modifications tested, WIoU v3 loss achieved the highest detection accuracy ($\text{mAP}@0.5 = 0.994$), outperforming the baseline (0.988) and CBAM/SPD-Conv variants. Since the tracking pipeline relies on robust detection rather than sub-pixel localization, the WIoU v3 model was selected as the final detector. ByteTrack successfully maintained individual IDs despite frequent occlusions, and the ROI-based analysis automatically quantified per-bird feeding and drinking frequencies. Automated counts showed strong agreement with manual observations for both feeding ($r = 0.906$) and drinking ($r = 0.970$) visits, validating system accuracy. The proposed pipeline enables practical, non-invasive individual broiler monitoring applicable to precision livestock farming. Future work will correlate the measured behavioral patterns with growth performance and health indicators. Supported by NRF/MSIT (RS-2024-00344849).

Key words : broiler, precision livestock farming, YOLOv12, object tracking, behavior analysis

Effects of *in ovo* feeding of β -hydroxy- β -methylbutyrate on hatching performance, hatchability, and morphometric parameters in newly hatched Japanese quail chicks

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This study evaluated the effects of *in ovo* feeding (IOF) of β -hydroxy- β -methylbutyrate (HMB) on hatching performance, hatchability, and morphometric parameters in newly hatched Japanese quail chicks. A total of 468 eggs from 16-week-old Japanese quail breeder flocks were randomly assigned to 3 treatments with 6 replicates of 26 eggs each. The treatments consisted of a non-injected control, a 1× PBS injection, and an HMB injection. On embryonic day 7, Japanese quail eggs in the injected groups received 50 μ L of either 1× PBS or HMB solution into the air cell. The HMB solution contained 0.5% HMB dissolved in 1× PBS. All eggs were incubated at $37.5 \pm 0.2^{\circ}\text{C}$ and $60 \pm 3\%$ until embryonic day 14. Thereafter, the temperature was maintained at 37.5°C and relative humidity was increased to $70 \pm 3\%$ until hatching. After hatching, one 1-day-old chick per replicate with a body weight (BW) close to the average of each treatment group was selected to evaluate morphometric parameters. Results indicated that hatch of set was greater ($p < 0.05$) in the HMB group than in the PBS group. Chicks in the HMB group had greater ($p < 0.05$) BW and chick yield than those in the control and PBS groups. Furthermore, early embryonic mortality was lower ($p < 0.05$) in the HMB group than in the control and PBS groups. In conclusion, IOF of HMB may improve hatching performance and reduce early embryonic mortality in Japanese quail chicks.

Key words : embryonic day, hatching performance, β -hydroxy- β -methylbutyrate, *in ovo* feeding, Japanese quail

Effects of a coated functional feed additive on growth performance, nutrient digestibility, and meat quality in growing-finishing pigs

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This study was conducted to evaluate the effects of dietary supplementation with a coated complex functional feed additive (coated essential oils, coated organic acids, vitamin E, and selenium) on growth performance, nutrient digestibility, blood profiles, and meat quality in growing-finishing pigs. A total of 90 three-way crossbred [(Landrace × Yorkshire) × Duroc] growing pigs (initial BW 59.39 ± 5.78 kg) were assigned to 3 treatments: CON (basal diet), T1 (CON + 0.02% additive), and T2 (CON + 0.05% additive), with 3 replicates of 10 pigs each for 9 weeks. T1 and T2 showed significantly improved average daily gain and feed conversion ratio throughout the experimental period ($p < 0.05$). At week 3, dry matter, crude protein, and gross energy digestibility were significantly higher in T1 and T2 than CON ($p < 0.05$). At week 9, eosinophil counts and MDA concentrations were significantly decreased, while blood selenium was significantly increased in additive-supplemented groups ($p < 0.05$). T1 and T2 exhibited significantly lower TBARS values at both week 0 and week 1 of storage compared with CON ($p < 0.05$). These results suggest that dietary supplementation with 0.02–0.05% of the coated complex additive improves growth performance, nutrient digestibility, and meat quality through oxidative stress reduction in growing-finishing pigs.

Key words : growing-finishing pigs, coated essential oils, organic acids, selenium, vitamin E, growth performance, meat quality

Precision livestock monitoring of lactating sows: YOLOv8-based behavioral analysis under varying feeding strategies

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This study evaluated the effects of feeding frequency and thermal environment on lactating sow behavior using a YOLOv8l-based computer vision model. Eight behaviors were detected: feeding, not feeding, suckling, not suckling, lateral lying, sternal lying, standing, and sitting. The model showed high detection performance, with precision of 0.943, recall of 0.950, F1-score of 0.946, and mAP@50 of 0.965. Three groups were compared: feeding five times/day with air conditioning, hourly feeding with air conditioning, and hourly feeding without air conditioning. Hourly feeding with air conditioning increased suckling and feeding frequency and reduced feeding interval, indicating improved sow–piglet interaction. In contrast, hourly feeding without air conditioning increased lateral lying, suggesting thermoregulatory responses under warmer conditions. These results demonstrate that frequent feeding combined with thermal control can improve lactating sow behavioral patterns, while YOLOv8l provides a reliable tool for automated precision livestock monitoring.

Key words : feeding frequency, thermal environment, computer vision, YOLOv8, behavioral monitoring, posture analysis

Processing-dependent effects of black soldier fly larvae on nutrient digestibility, palatability, and fecal microbiota in cat

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This study evaluated the effects of two drying methods (microwave drying and hot-air drying) for black soldier fly larvae (*Hermetia illucens*; HI) on nutrient digestibility, palatability, and fecal microbiota composition in cats. Three experimental diets were formulated: CON, basal diet; MW, basal diet with 3% poultry meal (PM) replaced by microwave-dried HI; HA, basal diet with 3% PM replaced by hot-air dried HI. *In vitro* digestibility (6 replicates/diet) showed significantly higher ($p < 0.05$) organic matter and crude protein (CP) digestibility in HA compared to MW and CON. Palatability assessed by two-bowl test (18 cats) showed no significant differences in any pairwise comparison. *In vivo* apparent total tract digestibility (12 cats, triplicated 3×3 Latin square) revealed significantly higher ($p < 0.05$) CP and ether extract digestibility in HA versus CON. Fecal microbiota analysis showed lower ($p < 0.05$) Chao1 index in MW at 10d, significant community separation by unweighted UniFrac, decreased ($p < 0.05$) *Prevotella* with HI inclusion, and reduced ($p < 0.05$) uncultured bacterial taxa in both HI groups. These results suggest that hot-air dried HI at 3% inclusion is a viable alternative protein source for cat diets, improving CP and EE digestibility without compromising palatability while inducing selective shifts in fecal microbiota.

Key words : black soldier fly larvae, cat, nutrient digestibility, palatability, drying method, fecal microbiota

Evaluation of the nutritional value and feeding efficacy of Adzuki beans (*Vigna angularis*) as a pet food ingredient in dogs

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This study was conducted to evaluate the nutritional value of adzuki beans as a pet food ingredient, as well as their feeding safety and efficacy in dogs. Eight 7-year-old spayed female dogs were used as experimental subjects. The study was designed as a randomized 2 × 2 crossover design, comparing a control diet based on rice and chicken with a treatment diet containing 10% adzuki beans. All experimental diets met the recommended nutrient requirements established by the Association of American Feed Control Officials (AAFCO), and restricted feeding was implemented according to the metabolizable energy requirements of each individual. During the experimental period, body weight was maintained in the control group, whereas dogs in the treatment group showed an approximate 7.9% reduction in body weight at the end of the trial (10.19 kg) compared to baseline (11.08 kg) ($p < 0.01$). The apparent total tract digestibility of crude protein (98.7% vs. 87.1%) and total amino acids (93.80% vs. 88.58%) was lower in the treatment group compared to the control group ($p < 0.01$). Palatability and safety evaluations showed no significant differences between groups, and all hematological parameters (complete blood count and serum biochemistry) were within normal reference ranges. Following adzuki bean supplementation, microbial community composition (observed features and presence/absence-based beta diversity) was significantly altered, while overall diversity structure remained unchanged. Notably, in the treatment group, relative abundances of *Proteobacteria* (9.95% vs. 4.32%) and *Actinobacteriota* (5.31% vs. 1.54%) increased after supplementation compared to pre-supplementation, without major changes in dominant phyla composition.

Key words : Adzuki beans, dogs, ingredient, nutrition, gut microbiome

Aflatoxin risk assessment of commercial dry dog food

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식품과 사료에는 다양한 유해 물질이 존재하며, 그중에서도 곰팡이 독소는 가장 광범위하게 오염되어 있고, 독성이 강한 물질로 알려져 있다. Aflatoxin(AF)은 강력한 독성과 발암성을 지닌 화합물로, 곡물 기반 사료 섭취를 통해 반려동물에게 노출될 수 있다. 특히 개는 AF에 민감하여 간독성과 면역억제를 유발할 수 있다. 따라서 반려동물 사료의 안전성 확보는 매우 중요하다. 본 연구는 한국에서 시판되는 건식 개 사료의 AF 오염 수준 및 위험을 평가하기 위해 수행되었다. 총 75개의 건식 개 사료 샘플을 수집하여 분쇄 및 균질화한 후 AF를 추출했다. 추출물은 면역친화성 컬럼(IAC)을 이용하여 정제하고 유도체화한 후 HPLC-FLD를 이용하여 정량 분석했다. 분석 방법은 검량곡선, 검출 한계(LOD), 정량 한계(LOQ), 회수율 및 반복성을 통해 검증했다. 체중 범주별 사료 섭취량을 적용하여 평균 및 극단적 노출 시나리오를 모두 고려한 노출 평가를 수행했다. 그 결과, 모든 샘플에서 AFB1이 검출되었으며, 체중이 적은 개일수록 노출 수준이 높았다. 특히 초소형 견에서 가장 높은 노출 수준과 암 발생 위험률(%) 증가가 나타났다. 또한 곡류를 포함한 식물성 원료 기반 사료에서 AF 오염이 상대적으로 높게 나타나는 경향이 관찰되었다. 이는 곡류 및 곡류 부산물이 곰팡이독소 오염에 취약한 특성에 기인한 것으로 판단된다. AFB1 함량은 법적 기준치를 초과하지 않았으나, 장기간 섭취 시 만성 질환 발생 위험이 있을 가능성이 MOE, ECR, EDI를 통해 확인했다. 장기간 동일 사료를 섭취하는 반려견의 특성을 고려할 때 이러한 노출은 더욱 중요하게 평가될 필요가 있음을 시사한다.

Key words : mycotoxin, aflatoxin, dog food, risk assessment, chronic toxicity, excess cancer risk

A novel procedure of the multi-sample simultaneous *in vitro* assay for protein digestibility of dog diets

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The conventional *in vitro* method using flasks has a limitation that only one sample can be incubated per flask. However, the multi-sample simultaneous *in vitro* assay using the Daisy^{II} incubator, specifically designed to mimic protein digestion in dogs, has not yet been established. Therefore, the objective was to develop a novel *in vitro* procedure using the Daisy^{II} incubator for simultaneous assays of multiple dog diet samples. The *in vitro* ileal disappearance of crude protein (CP) determined using flasks (IVID_{flask}) in 18 commercial dog diets was obtained. To develop a novel *in vitro* ileal disappearance (IVID_{Daisy}) procedure using the Daisy^{II} incubator, 2 incubation periods (2 and 1 h in step 1 and 4 and 2 h in step 2) and 2 enzyme concentrations (pepsin 10 and 5 g/L in step 1 and pancreatin 100 and 50 g/L in step 2) were tested in a 2 × 2 factorial arrangement for 18 commercial dog diets. The IVID_{Daisy} of CP in the 18 dog diets determined using the procedure with 5 g/L of pepsin supplementation and 2 h incubation for the stomach digestion and 50 g/L of pancreatin supplementation and 4 h incubation for the small intestine digestion was closest to the IVID_{flask} of CP among the Daisy^{II} incubator procedures. In conclusion, a novel multi-sample simultaneous *in vitro* procedure was developed using the Daisy^{II} incubator by adjusting incubation periods and enzyme concentrations to determine protein digestibility of dog diets.

Key words : Daisy^{II} incubator, dogs, *in vitro*, protein digestibility

Effect of dietary supplementation of magnesium oxide and magnesium sulfate on productive performance, egg quality, and eggshell ultrastructure in laying hens

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The current study aimed to investigate the effect of dietary supplementation with magnesium oxide (MgO; MO) and magnesium sulfate (MgSO₄; MS) on productive performance, egg quality, and eggshell ultrastructure in laying hens. A total of 180 Hy-Line Brown laying hens (37 weeks of age) were randomly allotted to 1 of 3 dietary treatments with 6 replicates consisting of 10 hens per replicate. The control (CON) diet was prepared to meet nutrient and energy requirement for laying hens. The CON diet contained 0.125% Mg. Two additional diets were prepared by supplementing 0.085% MgO or 0.512% MS, each providing an additional 0.05% Mg to the CON diet. Productive performance was determined for 12-week feeding trial. At the end of the experiment, egg quality was measured and eggshell ultrastructure was analyzed using a scanning electron microscope. Laying performance was not influenced by dietary treatments, except that the MS diet had greater ($p < 0.05$) feed intake than the MO diet. MO and MS diets had greater ($p < 0.05$) eggshell thickness than the CON diet, while the MS diet improved eggshell strength compared with the CON diet. For eggshell ultrastructure, both MO and MS diets increased ($p < 0.05$) overall thickness, effective layer thickness, and effective layer rate, but decreased ($p < 0.05$) mammillary layer rate compared with the CON diet. Between MO and MS diets, the MS diet showed greater ($p < 0.05$) overall thickness and effective layer thickness than the MO diet. Dietary supplementation of MO and MS at the level of 0.05% Mg in layer diets improves eggshell strength and ultrastructure. It appears that MS supplementation is more effective in improving eggshell ultrastructure than MO supplementation.

Key words : egg quality, eggshell ultrastructure, laying hen, magnesium oxide, magnesium sulfate

Meta-analysis of interactive effects of dietary digestible total sulfur amino acids and crude protein on productive performance in early laying hens

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The current meta-analysis was conducted to determine the optimal relationship between digestible total sulfur amino acid (TSAA) and crude protein (CP) levels for improving productive performance in laying hens, with a specific focus on the early laying phase. A total of 28 studies published between 2010 and 2026 were selected according to PRISMA guidelines, and datasets belonging to early laying phase (less than 35 wk of age) were extracted for the analysis. To evaluate the interactive effects of digestible TSAA and CP in diets on laying performance (average daily feed intake, ADFI; egg production, EP; egg weight, EW; egg mass, EM; feed conversion ratio, FCR), a quadratic regression model based on the product term of dietary digestible TSAA and CP (TSAA×CP) was employed. The linear and quadratic terms of the TSAA×CP value were included as fixed effects, incorporating study as a random intercept. Models were selected to predict optimal values only when the intercept, linear coefficient, and quadratic coefficient were all significant ($p < 0.05$). Based on the selected models, optimal digestible TSAA levels were calculated by identifying the stationary point of the fitted quadratic equations across fixed dietary CP levels ranging from 12.0% to 20.0%. The quadratic regression models were significant ($p < 0.05$) for ADFI and FCR, with corresponding relative root mean square prediction error (RMSPE%) and concordance correlation coefficient (CCC) values of 9.8 and 0.14 for ADFI, and 16.1 and 0.24 for FCR, respectively. The model for FCR exhibited a greater CCC value compared with ADFI, indicating a stronger model agreement. This model also indicates that optimal digestible TSAA levels in the early laying phase to minimize FCR increased significantly by 0.01 to 0.05 percentage points for each 0.5 percentage point reduction in dietary CP levels. In conclusion, the present meta-analysis demonstrates that optimal digestible TSAA levels for early laying hens increase with decreasing CP levels in diets, providing a practical strategy for determining optimal TSAA levels under varying dietary CP levels to improve productive performance in early laying phase.

Key words : crude protein, laying hen, meta-analysis, productive performance, total sulfur amino acid

Effects of multi-enzyme supplementation on growth, nutrient utilization, and intestinal health in broilers under nutrient-deficient diets

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This study evaluated the efficacy of multi-enzyme supplementation in mitigating the growth and physiological impairments caused by nutrient-deficient diets in broilers from 10 to 35 days of age. A total of 168 male Ross 308 broilers were assigned to three dietary treatments: a positive control (PC); a negative control (NC) with reduced metabolizable energy (–100 kcal/kg) and amino acids (–4.0%); and the NC diet supplemented with 500 g/ton of a multi-enzyme blend (NCME) containing xylanase, cellulase, β -glucanase, amylases, and proteases. Ileal segments and contents were collected for further analysis. Data were analysed using one-way ANOVA followed by Tukey's multiple range test. The nutrient-deficient NC diet significantly reduced body weight (BW) and average daily gain (ADG). However, multi-enzyme supplementation restored performance, with the NCME group (1,875.65 g) achieving a BW comparable to the PC group (1,960.03 g) by day 35. Average daily feed intake was not significantly affected, whereas ADG was higher in NCME group (64.01 g/bird/day) than in the NC group and comparable to the PC group (67.27 g/bird/day) over the entire study period ($p = 0.002$). Multi-enzyme supplementation did not significantly influence most carcass traits (dressing, breast, fat pad percentages) of broilers at days 21 and 35, although it resulted in a significant increase in leg meat percentage compared to control groups at day 35. Multi-enzyme inclusion significantly improved the apparent ileal digestibility (AID) of dry matter, energy, and crude protein. Notably, on day 35, the NCME group exhibited significantly higher AID of crude protein (78.90%) compared to the NC group (73.04%). Morphological analysis showed that multi-enzyme supplementation significantly increased ileal villus height on day 21 (910.54 μ m vs. 739.38 μ m in NC) and day 35 (1045.41 μ m vs. 920.87 μ m in NC) ($p < 0.05$). In conclusion, multi-enzyme supplementation mitigated the adverse effects of nutrient-deficient diets by improving growth performance, nutrient digestibility, and intestinal morphology.

Key words : digestibility, intestinal morphology, multi-enzyme, reduced amino acids, reduced energy

Effect of individual or combined supplementation of arginine and betaine in low-crude protein diets on growth performance, serum measurement, and liver health in broiler chickens raised under multiple stress conditions

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This study aimed to investigate the effect of individual or combined supplementation of arginine (ARG) and betaine (BET) in low-crude protein (LCP) diets on broiler performance, serum measurements, and liver health under multiple stress (MS) conditions. A total of 2,660 22-d-old Ross broiler chickens were randomly allotted to 5 dietary treatments with 7 replicates per treatment for a 14-d feeding trial. All birds were raised under MS conditions of heat stress ($30.0 \pm 0.43^{\circ}\text{C}$ for 8 h/d and $25.1 \pm 0.69^{\circ}\text{C}$ for 16 h/d) and high stocking density (18 birds/m²). Dietary treatments included control diet (CON), LCP diet by 3% CP reduction, and three LCP diets supplemented with 0.238% ARG, 0.20% BET, or their combination. Results indicated that the LCP diet did not affect performance, serum measurements, and liver health indicators compared with the CON diet. Compared with the LCP diet, however, BET supplementation improved body weight gain, but decreased feed conversion ratio ($p < 0.05$), while their improvements were numerically identified by ARG supplementation. No effect of ARG and BET combination on broiler performance was found. Individual and combined supplementation of ARG and BET reduced ($p < 0.05$) serum ALT levels without affecting serum AST and uric acid levels. While ARG or BET supplementation did not affect serum creatinine levels, their combination unexpectedly increased ($p < 0.05$) creatinine levels. Likewise, ARG or BET supplementation had no effects on liver health indicators, but their combination increased ($p < 0.05$) liver MDA levels with a numerical increase in hemorrhage score. In conclusion, LCP diets exert no negative impacts on broiler performance, serum measurements, and liver health. Individual ARG or BET supplementation in LCP diets improves broiler performance without synergistic effects of their combination. However, ARG and BET combination at the current supplemental levels may impair kidney and liver health.

Key words : arginine, betaine, broiler chicken, low crude protein diet, multiple stress condition

Reduced energy diet reformulation enhances growth performance and feed efficiency via improved intestinal morphology in broiler chicken

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This study evaluated the effects of a reformulated wheat-corn based diet with partial replacement of corn with alternative ingredients, reduced metabolizable energy, and optimized amino acid balance across three feeding phases (pre-starter, starter, and grower) on growth performance, blood biochemical parameters, and intestinal morphology in broiler chickens. A total of 280 one day old Ross 308 male broilers were randomly assigned to four dietary treatments (Con: conventional diet throughout; T1: reformulated diet during pre-starter only; T2: reformulated diet during starter and grower phases; T3: reformulated diet throughout) in a completely randomized design (10 replicates per treatment, 7 birds per replicate) over 35 days. The control group received a conventional diet, whereas treatment groups were fed reformulated diets with reduced energy (approximately 50 kcal/kg) and balanced amino acid composition using crystalline amino acids. Growth performance was not affected during the pre-starter and starter phases ($p > 0.05$). However, final body weight at day 35 was significantly higher in T3 compared with the control (2,460.54 vs. 2,295.23 g; $p = 0.015$), and overall feed conversion ratio was significantly improved (1.28 vs. 1.33; $p = 0.015$). Intestinal morphology analysis showed a significant increase in villus height in T3 at day 21 ($p = 0.009$), whereas crypt depth was not affected ($p > 0.05$). Blood biochemical analysis at day 35 showed that triglyceride concentrations were significantly reduced in T3 compared with the control (221.25 vs. 153.55 mg/dL; $p = 0.041$), and total cholesterol was also significantly lower (132.67 vs. 113.17 mg/dL; $p = 0.005$), while glucose and liver enzyme activities remained unchanged. These findings indicate that the reformulated diet enhanced nutrient utilization and growth efficiency without adverse metabolic effects.

Key words : broiler chickens, diet reformulation, feed efficiency, intestinal morphology, lipid metabolism, reduced energy diet

Modulatory effects of a novel functional oil feed additive on the intestinal microbiota of avian and mammalian models

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The intestinal microbiota composition is a critical determinant of health and physiological performance in livestock. This study investigated the modulatory influence of a newly developed functional oil-based feed additive on the gut microbiome of avian (chicken) and mammalian (mouse) models. Microbiome profiling via 16S rRNA gene sequencing revealed that oil supplementation significantly enhanced microbial richness and induced distinct structural reconfigurations in both models. In the chicken model, the additive effectively suppressed potential pathogens, including *Staphylococcus* ($p < 0.001$) and *Streptococcus* ($p < 0.05$), while promoting the proliferation of taxa associated with metabolic efficiency, such as *Cellulosilyticum* ($p < 0.001$), *Brevibacterium* ($p < 0.05$), and *Clostridium sensu stricto 1* ($p < 0.001$). In mice, the treatment exerted a prebiotic-like effect, characterized by a significant increase in the abundance of Lactobacillaceae ($p < 0.05$), *Bacteroides* ($p < 0.05$), and *Candidatus arthromitus* ($p < 0.05$), alongside a reduction in *Oscillibacter* ($p < 0.05$). Although body weight gain showed consistent numerical increases without reaching statistical significance, the observed microbial shifts suggest enhanced metabolic capacity and bolstered pathogen exclusion. These findings underscore the potential of this functional oil as a promising next-generation growth-promoting agent in diverse livestock species. Supported by NRF/MSIT (RS-2024-00344849).

Key words : functional oil, gut microbiome, 16S rRNA sequencing, growth promoter, pathogen suppression